Claims

What is claimed is:

1. A method for the production of a polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings, the method comprising:

a first electrolysis wherein an electric current is passed between two or more electrodes immersed in an electrolytic mixture comprising an ester, an electrolyte and an aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings;

harvesting the resultant polymer from the first electrolysis; and

a second electrolysis wherein an electric current is passed between two or more electrodes immersed in an electrolytic mixture, one or more of the electrodes including the harvested polymer from the first electrolysis, and the electrolytic mixture comprising an ester and an electrolyte.

2. The method of claim 1 wherein one or more of the electrodes on which the polymer from the first electrolysis is deposited are used as electrodes in the second electrolysis.

3. The method of claim 1 wherein the electrolyte in the electrolytic mixture of the first and second electrolysis are selected from the group consisting of $LiPF_6$, $NaPF_6$, KPF_6, $LiBF_4$, KBF_4, $(CH_3)_4NPF_6$, $(C_2H_5)_4NPF_6$, $(C_2H_5)_4NBF_4$, and mixtures thereof.

4. The method of claim 1 wherein the electrolytic mixture of the first electrolysis further comprises a solvent.

5. The method of claim 4 wherein the solvent is selected from the group consisting of acetonitrile, propionitrile, benzonitrile, nitromethane, nitroethane, nitrobenzene, tetrahydrofuan, diethyl ether, dimethoxyethane, dioxane, dichloromethane, dichloroethane, benzene, toluene, chlorobenzene, fluorobenzene, and mixtures thereof.

6. The method of claim 1 wherein the electrolytic mixture of the second electrolysis further comprises a solvent.

7. The method of claim 6 wherein the solvent is selected from the group consisting of acetonitrile, propionitrile, benzonitrile, nitromethane, nitroethane, nitrobenzene, tetrahydrofuan, diethyl ether, dimethoxyethane, dioxane, dichloromethane, dichloroethane, benzene, toluene, chlorobenzene, fluorobenzene, and mixtures thereof.

8. The method of claim 1 wherein the ester of the first or second electrolysis is selected from the group consisting of a simple ester, a carbonic ester, a lactone, a complex ester, and mixtures thereof.

9. The method of claim 8 wherein the ester is a simple ester selected from the group consisting of methyl formate, ethyl formate, methyl acetate, ethyl acetate, methyl propionate, ethyl propionate, methyl butylate, and mixtures thereof.

10. The method of claim 8 wherein the ester is a lactone selected from the group consisting of β-propiolactone, γ-butyrolactone, δ-valerolactone, ε-caprolactone, and mixtures thereof.

11. The method of claim 8 wherein the ester is a carbonic ester selected from the group consisting of ethylene, carbonate, propylene carbonate, butylenes carbonate, dimethyl carbonate, diethyl carbonate, ethyl methyl carbonate, and mixtures thereof.

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12. The method of claim 1 wherein the ester of the first electrolysis is at least 20% by volume of the electrolytic mixture.

13. The method of claim 1 wherein the ester of the second electrolysis is at least 20% by volume of the electrolytic mixture.

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14. The method of claim 1 wherein the first electrolysis further comprising a reference electrode for voltage control.

15. The method of claim 1 wherein the second electrolysis further comprises a reference electrode for voltage control.

16. The method of claim 1 wherein at least one of the electrodes in the first or second electrolysis is platinum, nickel, stainless steel, copper, carbon, PbO_2, titanium coated with platinum or titanium coated with PbO_2.

17. The method of claim 1 wherein the electrolyte of the first electrolysis is at a concentration of from 0.001 to 1 mol/L.

18. The method of claim 1 wherein the electrolyte of the second electrolysis is at a concentration of from 0.001 to 1 mol/L.

19. The method of claim 1 wherein the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings of the first electrolysis is at a concentration of from 0.01 to 10 mol/L.

20. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(9-fluorenone) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is fluorene.

21. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(cyclopenta[*def*]phenanthren-4-one) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is 4*H*-cyclopenta[*def*]phenanthrene.

22. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(8*H*-cyclopenta[*def*]fluoren-4-one) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is 4,8-dihydrocyclopenta[*def*]fluorene.

23. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(cyclopenta[*def*]fluoren-4,8-dione) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is 4,8-dihydrocyclopenta[*def*]fluorene.

24. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(benzo[*b*]fluoren-11-one) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is 11*H*-benzo[*b*]fluorene.

25. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(dibenzo[*b,h*]fluoren-12-one) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is 12*H*-benzo[*b,h*]fluorene.

26. The method of claim 1 wherein the polymer having at least one unit that contains at least one cyclopentanone structure condensed with at least two aromatic rings is poly(indeno[1,2-*b*]fluorene-6,12-dione) and the aromatic compound having at least one cyclopentane structure condensed with at least two aromatic rings is 6,12-dihydro-indeno[1,2-*b*]fluorene.

27. The polymer produced according to claim 1.

28. The polymer of claim 27 wherein at least 30% by weight of the polymer are units that contain at least one cyclopentanone structure condensed with at least two aromatic rings.

29. The polymer of claim 27 wherein at least 50% by weight of the polymer are units that contain at least one cyclopentanone structure condensed with at least two aromatic rings.

30. The polymer of claim 27 wherein at least 70% by weight of the polymer are units that contain at least one cyclopentanone structure condensed with at least two aromatic rings.

31. A light-emitting diode comprising the polymer produced according to claim 1.

32. The light-emitting diode of claim 31 wherein the light-emitting diode is a multilayer light-emitting diode.